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Exchange Rates and Local Labor Markets

Linda Goldberg and Joseph Tracy

8.1 Introduction

With the increased internationalization of the U.S. economy, the implications of dollar movements for workers has emerged as a pressing question. A literature has developed that considers this and related themes. First, the exchange rate pass-through literature discusses the degree to which prices of goods—whether exported, imported, or produced domestically for home consumption—are influenced by exchange rates. In the United States export prices tend to be fairly stable in dollar terms. Import prices appear to be more responsive to exchange rate movements, but this responsiveness varies considerably across types of goods and across trading partners. Import-competing product prices show much smaller elasticities of response to exchange rates.[1] Exchange rates also matter for producer profitability, and for decisions about capital spending and employment. Industry features—such as their trade orientation and competitive structure—scale the importance of these exchange rate effects.[2]

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1. See Goldberg and Knetter (1997) for a survey. The distribution of exchange rate elasticities of the set of U.S. import prices thus far examined appears to be centered around 0.5, but the set of goods studied is by no means exhaustive.

2. See Clarida (1997) and Sheets (1996) on profitability and exchange rates. Campa and Goldberg (1999) show that investment spending is time-varying in accordance with the ex-

The labor market effects of exchange rates are an open question. For the United States, analyses using data through the mid-1980s show that exchange rates have had significant implications for wages (Revenga 1992) and for employment across manufacturing industries (Branson and Love 1988).[3] A recent cross-country, cross-industry study by Burgess and Knetter (1998) found statistically significant effects of exchange rates for employment, with the size of these effects related to industry characteristics such as competitive structure.

However, recent work by Campa and Goldberg (1998) found weaker implications of exchange rates for employment in U.S. industries, but more pronounced effects for wages. This study used a longer time series than previous empirical work (about 25 years of annual data) and focused on two-digit industry employment, wages, overtime activity, and overtime wages. The testing methodology allowed for exchange rate transmission channels to vary over time with industry trade exposures to exchange rates through both revenues and costs. Exchange rate effects were statistically significant mainly for wages, and strongest in industries that were more trade oriented and in industries that generally had lower profit margins.

The combination of significant wage responsiveness to exchange rates without comparable employment effects poses some interesting questions. One possible reconciling argument is that a dollar appreciation, for example, could lead workers to lose their jobs, but then to be reemployed at lower wages within the same broad industry group but in a different, narrower industry definition. Such findings would be consistent with observed patterns of labor force adjustment within an industry to oil-price shocks (Davis and Haltiwanger 1999). If this is the case, a related question is whether workers take new positions in a similar industry within a local labor market, or if they look for opportunities in a similar industry elsewhere in the country. Employment changes can entail worker relocation as well as the type of wage adjustments from moving within and across manufacturing industries that have been detailed by Revenga (1992). Another argument is that under adverse employment conditions from a dollar appreciation, for example, workers may engage in less on-the-job searching for better-paying jobs.[4] Under these conditions, one might observe relatively stable employment with magnified wage restraint. By un-

port and imported-input orientation of producers across various industries and across countries and is strongest in industries with low price-over-cost markups (which can be viewed as closer to perfectly competitive market structures).

3. Examining the 1970s into the early 1980s, Branson and Love estimate that durable-goods producers had jobs that were most responsive to exchange rates. Using Revenga's computed elasticities, the estimated effects on jobs are increasing gradually to the extent that import competition exists in an industry.

4. See Mortensen (1986) for a discussion of on-the-job search models.

raveling these issues, we hope to better understand the degree of labor market disruption associated with dollar fluctuations.

The present paper examines more than 2 decades of data on average hourly earnings, hours, and employment for two-digit industries located within the individual states of the United States. This approach has several advantages over prior studies. First, since the trade orientation of industries varies by industry location, we are able to better identify the magnitude of currency shocks hitting local industries. Second, we are able to consider the spillovers of exchange rate effects across local industries. From a local labor market perspective, such spillovers may alter the alternative wage available to workers and help explain the magnified wage and reduced employment sensitivity to exchange rates. Third, by examining state-level data, we capture the adjustments made by workers who might move across state lines, yet remain within the same broad industry.

We find that real exchange rates contribute significant explanatory power to regressions on average hourly earnings, hours, and employment. In pooled industry regressions, dollar appreciations (depreciations) are associated with small but statistically significant declines (increases) in hourly earnings by workers. In individual industry regressions, we observe significant variability across industries in the levels of these earnings implications and even in the sign of these effects. Moreover, even within individual industries, some regions are particularly sensitive to dollar movements. Cross-industry spillovers, which we interpret as providing an indirect means of worker exposure to exchange rates, are significant for average hourly earnings and for employment within high-markup industries.

In contrast to results drawn from nationally aggregated data for industries, the state-level data exhibit more pronounced responsiveness of employment and hours worked within manufacturing industries. On balance, dollar appreciations (depreciations) are associated with employment declines (increases) for high- and low-profit-margin industry groups. As industries increase their export orientation, the adverse consequences of appreciations for employment also increase. However, some of these adverse consequences are counteracted as industries increase their reliance on imported inputs. Both forces are significant in determining the employment effects of exchange rates, and they differ qualitatively and quantitatively across regions and across industries.

Finally, our analysis also focuses on and confirms the type of dynamic patterns of adjustment in local labor markets previously reported by Topel (1986). Using Topel's methodology, we construct state- and industry-specific relative demand shocks, both actual and anticipated. Similar to Topel's finding using microdata, we find that wages increase in response to current relative demand shocks and decrease in response to expected future relative demand shocks.

8.2 The Theory

Our theoretical setup pairs a model of dynamic labor demand and exchange rate exposure (Campa and Goldberg 1998) with a dynamic local labor supply specification. The theory shows clear reasons why industries should be differentially affected by exchange rates. One reason is that industries differ in trade orientation. But, even controlling for these differences, exchange rate effects on wages and employment should vary across industries depending on (1) the industry product demand elasticity at home and abroad, (2) the initial labor share in production, and (3) the elasticity of the labor supply facing the industry in that locality. Industries with high labor-demand elasticity with respect to wages will exhibit more employment response and less wage response to exchange rate movements.

Each industry within each locality (defined as a state in our data) can experience shocks that alter its wages directly or indirectly. Direct effects of exchange rates arise because of own-industry trade orientation. Indirect effects are due to spillovers across local industries via expected alternative wages. Local unemployment rates are important since they influence the probability that a worker will be able to find a job that offers the alternative wage. Some shocks can change the current or future attractiveness of an entire locality and lead to labor-supply shifts through in- or out-migration, as in Topel (1986).

Controlling for direct and indirect effects of exchange rates could help identify the separate channels for wage and employment responsiveness. For example, if an industry is export oriented, in general a dollar appreciation is expected to reduce the competitiveness of its products and, as a consequence, place downward pressure on industry wages and lead to layoffs. However, if other local industries also are export oriented, the dollar appreciation can lower the alternative wage available to workers and locally expand the labor supply to the initial industry. The offsetting direction of movement in labor demand and labor supply to the industry may lead to magnified wage effects and muted employment effects.

8.2.1 Exchange Rates and Labor Demand

We begin with profit-maximizing producers who sell to both domestic and foreign markets. Producers make decisions in a dynamic and uncertain environment, and consider the future paths of all variables influencing their profitability. The unknowns for the producer are aggregate demand in domestic and foreign markets, y and y^*, and the exchange rate e, defined as domestic currency per unit of foreign exchange. Production uses three factors: domestic labor L, other domestic inputs Z, and imported inputs, Z^*. Factor prices are denoted by w, s, and es^*, respectively. Labor is a homogeneous input into production and levels of nonlabor inputs can be adjusted in the short run without additional costs.

Producers optimize over levels of factor inputs and total output in order to maximize expected profits π, equation (1); subject to the constraints posed by the production function, equation (2); and product-demand conditions in domestic and foreign markets, equation (3). Revenues arise from domestic market sales q and foreign market sales q^*. In both markets, the exchange rate influences demand by altering the relative price of home products versus those of foreign competitors. The exchange rate also directly enters costs through the domestic price of imported inputs.

$$(1)\quad \pi(y_t,y_t^*,e_t) = \max_{Q_t,L_t,Z_t^*,Z} \sum_{t=0}^{\infty}\phi_t\,[p(q_t:y_t,e_t)q_t + e_t p^*(q_t^*:y_t^*,e_t)q_t^* - w_t L_t - e_t s_t^* Z_t^* - s_t Z_t - c(\Delta L_t)],$$

subject to

$$(2)\qquad Q = q + q^*,\quad Q = L^{\beta}Z^{*\alpha}Z^{1-\alpha-\beta},$$

and

$$(3)\qquad p(q:y,e) = a(y,e)q^{-1/\eta},\quad ep^*(q^*:y^*,e) = a^*(y^*,e)q^{*-1/\eta^*}.$$

The time-discount factor is defined by $\phi_t = \Pi_\tau \delta^\tau$. In equations (2) and (3) we have dropped the period t time subscripts for convenience.[5] In equation (3) the parameters η and η^* are the domestic and foreign product-demand elasticities facing producers. The demand curves in domestic and foreign markets include multiplicative demand shifters, $a(y,e)$ and $a^*(y^*,e)$, which capture the influence of real income differences across markets and exchange rates.

It is assumed that an industry's labor input L is costly to adjust. We assume quadratic adjustment costs that are proportional to the prevailing wage in the industry; see equation (4). The parameter b allows for additional industry variation in the cost of adjusting employment levels.

$$(4)\qquad c(\Delta L_t) = w_t \frac{b}{2}(L_t - L_{t-1})^2.$$

Following Nickell (1986), the solution of this optimization problem is a dynamic equation for optimal labor demand, where labor adjusts toward a target level $\tilde{L}$ that would be optimal in the absence of adjustment costs. The speed of adjustment of labor demand to $\tilde{L}$, $(1 - \mu)$, is reduced when industries face high adjustment costs b and have low wage sensitivity of marginal revenue product. Nickell shows that labor demand in any period can be approximated by

5. A Cobb-Douglas production structure is assumed for simplicity, but our main results also will hold under a more general constant elasticity of substitution production structure.

$$(5) \qquad L_t = \mu L_{t-1} + (1 - \mu)(1 - \delta g\mu)\sum_{j=0}^{\infty}(\delta g\mu)^j \tilde{L}_{t+j},$$

where g is the rate of real wage growth for an industry. Solving the optimal labor problem of equations (1)–(4), Campa and Goldberg (1998) show that the labor-demand target $\tilde{L}$ is sensitive to exchange rates, with the effects of exchange rates transmitted through three separate channels—revenues from home market sales, revenues from foreign market sales, and costs of imported inputs into production. The elasticity of response of $\tilde{L}$ to exchange rates is

$$(6) \frac{\partial \tilde{L}}{\partial e} \Big/ \frac{\tilde{L}}{e} = \frac{1}{\beta}[p(\cdot)(1 + \eta^{-1})\eta^{pe} + \chi(ep^*(\cdot)(1 + \eta^{*-1})(1 + \eta^{p^*e}) - p(\cdot)(1 + \eta^{-1})\eta^{pe}) - \alpha e s^*(\partial Q/\partial Z^*)],$$

where $\chi^i = p^{*i}q^{*i}/(p^iq^i + p^{*i}q^{*i})$ represents the share of export sales in revenues, and η^{pe} and η^{p^*e} are domestic and foreign price elasticities with respect to exchange rates. Observe that the three groups of terms on the right-hand side of equation (6) correspond to the three exposure channels: the sensitivity to exchange rates of labor demand through revenues from domestic sales, revenues from foreign market sales, and the costs of productive inputs. By invoking basic relationships on exchange rate pass-through elasticities and ex ante law of one price, we rewrite this as

$$(6') \qquad \frac{\partial \tilde{L}}{\partial e} \Big/ \frac{\tilde{L}}{e} = \frac{p}{\beta}[(1 + \eta^{-1})kM + (1 + \eta^{*-1})\chi - (\partial Q/\partial Z^*)^{-1}\alpha].$$

Equation (6′) clearly shows the three channels and industry features that magnify or reduce the degree of industry response to exchange rate movements. First, more import penetration of domestic markets (M) increases the sensitivity of labor demand to exchange rates by increasing the price competitiveness of foreign goods. Second, more export orientation (χ) increases the sensitivity of labor demand to exchange rates, since export revenues are relatively more responsive to exchange rates. Third, greater reliance on imported components (higher α) can offset or even reverse the adverse consequences of a stronger currency (for example) on industry labor demand. Fourth, more-labor-intensive production (high β) is associated with a reduced sensitivity of labor demand to exchange rates. Finally, industries characterized by greater competition among firms (with low η or η^*) are expected to have labor demands that are more sensitive to exchange rates.

Using equations (5) and (6′), and introducing log-linearized terms for domestic and foreign aggregate demand conditions, we generate the following reduced form for optimal labor demand by an industry:[6]

$$(7)\quad L_t^i = \mu^i L_{t-1}^i + (1-\mu^i)[c_0 + c_1 y_t + c_2 y_t^* + (c_{3,0} + c_{3,1}\chi^i + c_{3,2}M^i + c_{3,3}\alpha^i)e_t + c_4 w_t^i + c_5 s_t + c_6 s_t^*],$$

where all variables other than χ^i, M^i, and α^i are defined in logs.[7] All variables and parameters are specific to an industry except for y_t and y_t^*.[8] Within an industry, state or regional differences in labor demand may arise from local differences in trade exposures.

8.2.2 Labor Supply

Our approach to labor supply focuses on the behavior of forward-looking workers in a local labor market. These workers choose their labor supply to an industry by considering the wages offered by that industry relative to the alternative wage (as offered locally by other industries). Local labor supply also responds to both current and expected future local demand conditions, all relative to conditions outside of the locality. As Topel (1986) demonstrates, these conditions can lead to in-migration to or out-migration from an area.

A reduced-form representation for labor supply to an industry i in a locality r is

$$(8)\quad L_t^{ir} = a_1^r + a_2^i(w_t^{ir} - \hat{w}_t^{ir}) + a_3^r y_t^r,$$

where y_t^r is a vector of terms for local relative conditions (current relative strength of the locality and expected future relative strength), and $\hat{w}^{ir}$ is the alternative wage in industries outside of industry i in the locality.[9] Exchange rates can shift the labor-supply curve facing an industry in a locality through their impact on the alternative wage, with the magnitude of the shift depending on the trade orientation of the other local industries, $\overline{X}^{ir}$.[10] The

6. Changes in foreign-currency input costs through foreign wages are absorbed into the α term.

7. The actual parameters on the shocks introduced in our equation (7) depend on the perceived degree of permanence of the shock. A shock that is transitory will have a much smaller impact on labor demand than a shock that is viewed as permanent.

8. Real bilateral exchange rates all are exogenous to an industry. These bilateral exchange rates with currencies of individual countries are weighted differently for each industry, depending on the importance of a country as the industry's trading partner.

9. Labor supply is upward sloping in an industry's wage if there is heterogeneity in the workforce, either in terms of preferences for industry job attributes or mobility costs.

10. The alternative wage should be viewed as an equilibrium alternative wage, so that it, in fact, would be a function of all of the variables that shift labor demand, as shown in equation (7). Introducing this full set of terms at this point would complicate the notation and have no bearing on our ultimate estimation structure or our interpretation of the ex-

likelihood that industry i workers could get this alternative wage depends on the tightness of local labor markets. We proxy this tightness as inversely related to the local unemployment rate $Unemp^r$. So, $\hat{w}_t^{ir} \approx a_4^{r\prime}\overline{X}^{ir}e_t + a_5^{r\prime}\, Unemp_t^r$, and we write the new reduced form equation for labor supply as

$$(9) \qquad L_t^{ir} = a_1^r + a_2^i w_t^{ir} + a_3^r y_t^r + a_4^r \overline{X}^{ir} e_t + a_5^r Unemp_t^r,$$

for industry i in a state/region r.

8.2.3 Labor Market Equilibrium

Setting labor demand by a local industry, equation (7), equal to local labor supply, equation (9), yields equations in industry employment and wages,[11]

$$(10a) \qquad w_t^{ir} = \omega_0^{ir} + \omega_1^i y_t + \omega_2^i y_t^* + \omega_3^i s_t + \omega_6^{ir} Unemp_t^r + (\omega_{5,0}^i + \omega_{5,1}^i X^i + \omega_{5,2}^i M^i + \omega_{5,3}^i \alpha^i + \omega_{5,4}^{ir} \overline{X}^{ir}) \cdot e_t + \omega_6^i y_t^r + \omega_7^i L_{t-1}^i,$$

$$(10b) \qquad L_t^{ir} = \lambda_0^{ir} + \lambda_1^i y_t + \lambda_2^i y_t^* + \lambda_3^i s_t + \lambda_4^{ir} Unemp_t^r + (\lambda_{5,0}^i + \lambda_{5,1}^i X^i + \lambda_{5,2}^i M^i + \lambda_{5,3}^i \alpha^i + \lambda_{5,4}^{ir} \overline{X}^{ir}) \cdot e_t + \lambda_6 y_t^r + \lambda_7^i L_{t-1}^i.$$

Equations (10a) and (10b) form the basis for our tests of exchange rate and local-demand effects on the labor market of industry i operating in region r. The wage and employment response in an industry to local shocks depends on the elasticities of labor demand and supply, as well as the costs of adjusting employment in that industry. When labor-demand or -supply curves are steep—indicating low employment sensitivity to wages—shocks to either demand or supply lead to relatively less employment response and more wage response. When industries have high labor force adjustment costs, the short-run shift in labor demand in response to any given shock is smaller. Given an industry's trade orientation, a more concentrated (and less competitive) industry will experience a smaller labor-demand shift from any given shock.

change rate channels. The existence of these other terms would matter for the interpretation of coefficients on the domestic and foreign income and factor-price terms in the regressions, if one were to attempt a semistructural interpretation of these coefficients.

11. The coefficients on the interacted exchange rate terms are interpreted in relation to the individual labor-demand and labor-supply equations in Campa and Goldberg (1998). The main difference between the current system of equations (11) and the prior paper is the inclusion of local labor market effects and the dynamic labor-supply decision.

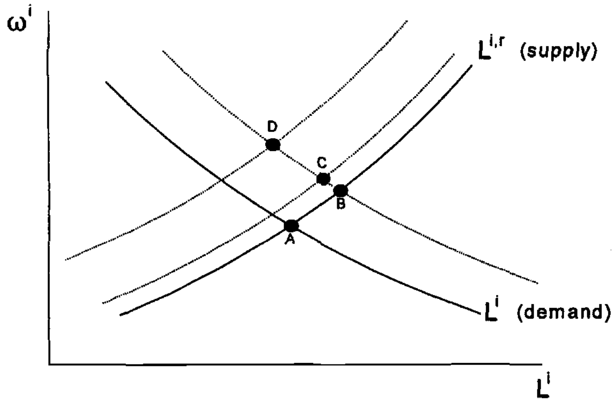

Fig. 8.1 Local labor market equilibrium for industry *i*

The effects of a dollar depreciation on wage and employment in a particular industry are illustrated in figure 8.1. For an industry with external orientation mainly through its export sales, a dollar depreciation increases labor demand. In the absence of a labor-supply shift, labor market equilibrium moves from point *A* to point *B*. The direct effects of the depreciation are expanded employment and higher wages in the industry. Yet, if other local industries are also trade oriented, labor supply to industry *i* might contract if alternative wages rise in those other industries. The decline in labor supply to industry *i* because of the exposure of other local industries moves the equilibrium to point *C* or point *D*. These indirect effects can be moderate (point *C*), so that local-labor-market spillovers mitigate some of the employment effect of the dollar depreciation, but reinforce the wage effect. However, if the wages of other local industries are very sensitive to exchange rates, employment in the initial industry can be unchanged or even may contract (point *D*). A depreciation generally raises wages, provided that the dominant channels of industry exposure are through favorable revenue effects.

8.3 Data

8.3.1 Labor Market Series

The dependent variables in our study are average employment, hours and wages from the Bureau of Labor Statistics (BLS) *Employment and Earnings* with all data disaggregated by two-digit Standard Industrial Classification (SIC) industry. We consider the movements in the national data (as a means of generating a set of reference facts), as well as in data disaggregated by states and areas.[12] Firms are classified into industries based on their principal product using 1987 SIC classifications.

The *employment data* capture all persons on establishment payrolls who received pay for any part of the pay period that includes the 12th day of the month. Proprietors, self-employed workers, unpaid volunteers and family workers, and domestic workers are excluded. Workers on paid vacation or sick leave are counted, as are workers who are unemployed or on strike for some but not all of the pay period. The *hours data* reflect hours paid, which may differ from scheduled hours or hours worked. Overtime hours and hours paid to workers on vacation or sick leave are included. Worker absenteeism and work stoppages cause paid hours to fall below scheduled hours and are not included.

The *earnings data* reflect average weekly earnings divided by average weekly hours. Workers who are not paid weekly have their earnings and hours expressed on a weekly basis. Earnings reflect payments for all workers who were on the payroll for any part of the pay period covering the 12th of the month. Gross payroll prior to deductions for social security, life insurance, tax withholding, and union dues is used. Overtime, holiday, and incentive pay as well as regular bonus payments are included, while nonregular bonus payments are excluded. Firm contributions to fringe benefits, such as health insurance and retirement accounts, are not included.

8.3.2 Exchange Rate Series

Our empirical work uses export and import real exchange rates for each industry. These industry-specific real exchange rates are constructed by weighting the bilateral real exchange rates of U.S. trading partners in accordance with the importance of these partners in industry exports or imports in each year. To convert nominal exchange rates into real series, the nominal measures are adjusted by the GDP deflators of the respective trade partners (*International Financial Statistics* data). The resulting real trade-weighted dollar exchange rates follow the empirical convention that an increase in the exchange rate corresponds to an appreciation of the dollar. This convention is opposite that used in our theoretical section.

We use industry-specific exchange rates, rather than a common trade-weighted measure, because these better reflect the actual shocks to individual industries. The industry-specific series are generally highly correlated with the overall real exchange rate for the United States (appendix table

12. These data are derived from the Current Employment Statistics survey that is sent out monthly to all employers with at least 250 workers and a random sample of smaller employers. We exclude Alaska, Hawaii, and the District of Columbia from the state data. The data span the years 1971 through 1995. See U.S. Department of Labor (1997) for details. This sampling implies that smaller employer response to stimuli may be less well captured by the data set.

8A.1 provides correlation coefficients). However, for some industries the export exchange rates clearly are more similar to the aggregate real exchange rate measure than are the import exchange rates. The industry for which the export exchange rate is least correlated with the aggregate measure is lumber and wood products, with a 0.63 correlation coefficient. On the import index side, the correlation coefficients between the industry exchange rates and the aggregate real exchange rate were as low as 0.36 for the petroleum and coal industry, 0.50 for paper and allied products, and 0.58 for lumber and wood products. Therefore, our industry-specific series are more appropriate for capturing industry-specific shocks to import competitiveness or imported input providers.

8.3.3 Industry Trade-Orientation Series

In some regression specifications, we interact the real exchange rates with measures of industry export share and imported input share (Campa and Goldberg 1997, constructions based on U.S. Department of Commerce series and U.S. input-output tables). These industry series are not differentiated across states or regions of the United States.

We are able to perform such state differentiation for our export measures by using a shorter time series of export data reported by state of origin and by industry, compiled by the Massachusetts Institute for Social and Economic Research (MISER).[13] These series are only available by two-digit SIC beginning in 1988. For our regressions, we take this information on the relative importance of exports to an industry in a state over this shorter time period, and use it to scale, at the state level, the longer annual series on national export orientation numbers for each industry.

These state-specific data on industry exports make a powerful statement about the diversity of export orientation of industries located in different areas of the United States. To demonstrate this point, figure 8.2 shows the degree of export orientation of production in each state, based on the MISER data.[14] The more export oriented areas include the Pacific region, Texas, Florida, New York, Vermont, and the Carolinas. Indeed, according to these measurements, which use the value of exports to gross state product, Vermont is the most export-oriented state.

13. Comparable numbers are not available for imported-input share of industries by state.

14. To construct this map we used MISER data on the export orientation of manufacturing industries in each state, weighted these series by the importance of the specific industry within the state, and assumed a 0 export share on output of nonmanufacturing industries,

$$\left(\frac{\text{manufacturing GSP}}{\text{total GSP}}\right) \cdot \sum_j \left(\left(\frac{\text{state employment in industry } j}{\text{total state manufacturing employment}}\right) \cdot \left(\frac{\text{MISER exports}}{\text{industry } j \text{ GSP}}\right)\right).$$

This measure is computed using data for each year between 1988 and 1994, and averaged over these 7 years of data.

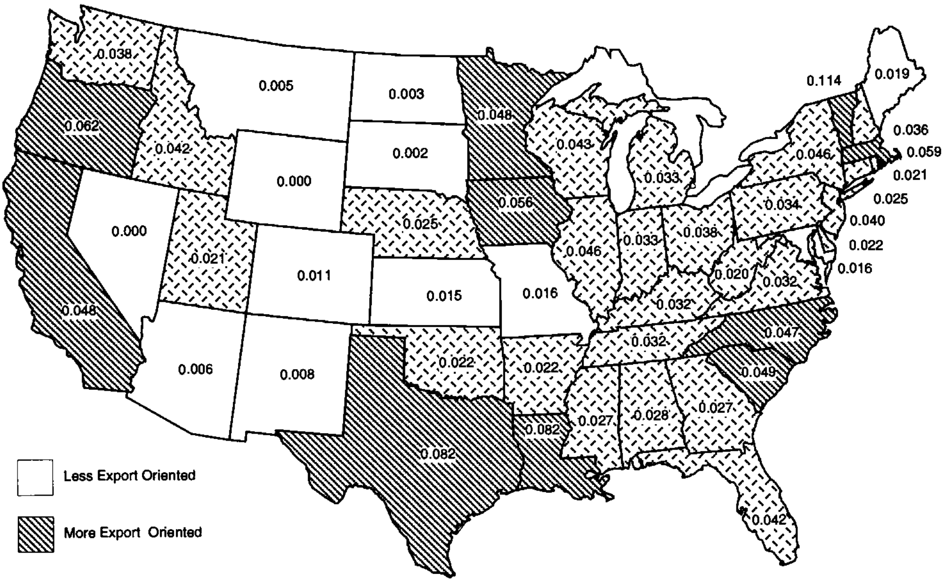

Fig. 8.2 State export orientation, 1988–94 average
Notes: State export orientation is calculated as the weighted sum across manufacturing industries of the MISER export orientation. The MISER export orientation is MISER exports over gross state product (gsp), where each is state and industry specific. The weight that is used to sum across industries is state- and industry-specific employment over state manufacturing employment. The sum is then multiplied by manufacturing gsp over total gsp.

Figure 8.3 shows the biased view of state-export orientation that would arise if one used national export shares for individual industries of individual states. This map presents the ratio of state export orientation as implied by the MISER data versus that implied by the overall national export shares of the industries.[15] A value greater than one on this map indicates that the export orientation of a state (based on MISER data) is greater than that implied using the national data on industry export orientation. The states with dark shading have the most understated export orientation when the national data on industry export shares are used; the states without shading have the most overstated export orientation from national series. For some states this misrepresentation can be enormous. The national aggregates vastly overstate the export orientation of manufacturing industries in the Mountain region and vastly understate the export orientation of various coastal and border areas.

15. Again, we assume that the nonmanufacturing industries within a state have no export orientation. The implied state export share is the weighted average of the industry export shares, where the weights are the industry shares in state output.

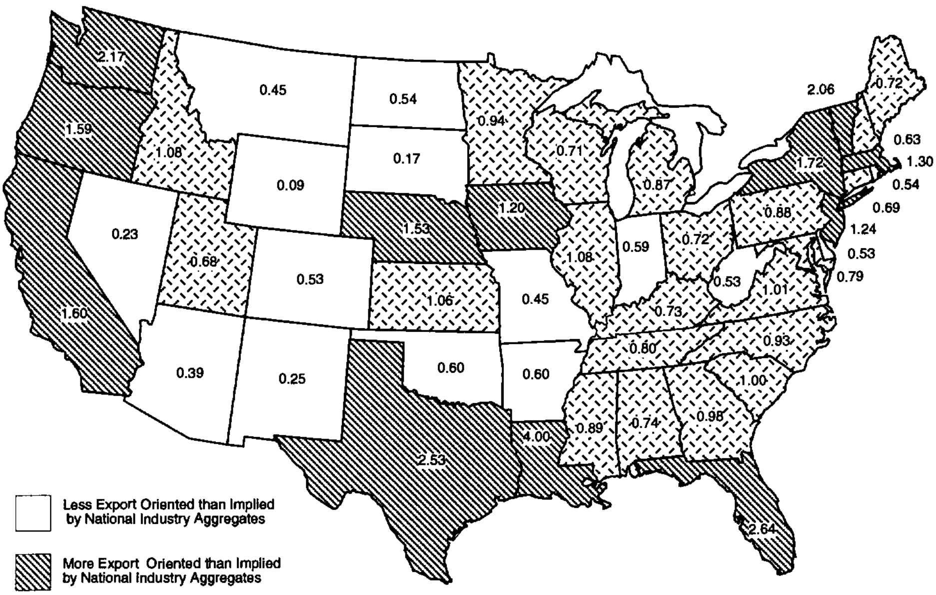

Fig. 8.3 State export orientation, ratio of actual to implied, 1988–94 average

Notes: Ratio of actual to implied state export orientations is calculated as the weighted sum across manufacturing industries of the MISER export orientation over the national industry export orientation. The MISER export orientation is MISER exports over gross state product, where each is state and industry specific. The weight that is used to sum across industries is state- and industry-specific employment over state manufacturing employment.

8.3.4 Other Data

Aggregate demand conditions are proxied by (the change in log) real GDP (IMF International Financial Statistics, line 99b). Other factor costs are captured by (the change in log) real oil prices (line 001) and the (change in log) 10-year T-bill rate deflated by the wholesale price index. The aggregate prime-age-male unemployment rate is our proxy for national labor market tightness. The state prime-age-male unemployment rate is our proxy for local labor market tightness.

Our regressions also include measures of local relative demand shocks. We use an adaptation of Topel's (1986) empirical methodology for measuring current and anticipated relative demand shocks to a local labor market. Like Topel, we use states as our definition of a local labor market. For each industry in a state we adjust the employment in the state by subtracting out the employment for that industry. The current relative demand shock for industry i in state r during year t measures the percentage deviation of the adjusted state employment from its trend relative to the percentage deviation of national employment from its trend in year t (see the appendix for details). This variable captures the extent to which the current local labor-demand conditions deviate from the national labor-demand conditions.

We use the persistence of this measure of local relative demand shocks to control for future local relative demand shocks. We regress the current local relative demand shock measure for a given industry and state on its value lagged 1 and 2 years and on the current national demand shock measure. We use this estimated model to generate forecasts of future relative demand shocks to the locality. Our measure for anticipated future local relative demand shocks is a weighted average of the 1-, 2-, and 3-year forecasts.

8.4 Empirical Results

8.4.1 Regression Method

Starting with the basic forms of equations (10a) and (10b), we estimate the wage and employment equations in first differences using weighted least squares, with lagged industry employment providing the weights. The estimation equations are repeated here.

$$\begin{aligned}\Delta w_t^{ir} = {} & \omega_0^{ir} + \omega_1^i \Delta y_t + \omega_2^i time + \omega_3^i \Delta s_t + \omega_6^{ir} \Delta Unemp_t^r \\ & + (\omega_{5,0}^i + \omega_{5,1}^i X^{ir} + \omega_{5,2}^i M^i + \omega_{5,3}^i \alpha^i + \omega_{5,4}^{ir} \overline{X}^{ir}) \cdot \Delta e_t^i \\ & + \omega_6^i \Delta y_t^{ir} + \omega_7^i \Delta L_{t-1}^i,\end{aligned}$$

$$\begin{aligned}\Delta L_t^{ir} = {} & \lambda_0^{ir} + \lambda_1^i \Delta y_t + \lambda_2^i time + \lambda_3^i \Delta s_t + \lambda_4^{ir} \Delta Unemp_t^r \\ & + (\lambda_{5,0}^i + \lambda_{5,1}^i X^{ir} + \lambda_{5,2}^i M^i + \lambda_{5,3}^i \alpha^i + \lambda_{5,4}^{ir} \overline{X}^{ir}) \cdot \Delta e_t^i \\ & + \lambda_6 \Delta y_t^{ir} + \lambda_7^i \Delta L_{t-1}^i.\end{aligned}$$

The implied unit of observation is a worker in manufacturing, not a state or SIC aggregate. All regressions include industry fixed effects, industry time trends, and lagged changes in industry employment. Regressions using state data also include state fixed effects and state time trends. All regressions control for the percentage change in real GDP, the percentage change in real oil prices, the percentage change in real interest rates, and the unemployment rate (at national or state levels, as appropriate). The regressions using state-level data allow the coefficients on these aggregate variables to vary by industry.[16] The interacted-trade-shares for each industry are lagged by one period to avoid simultaneity issues.

16. By including the industry-specific coefficients, along with the state and industry fixed effects and trend terms, we reduce the likelihood that our regressions are plagued by the problems caused by combining explanatory variables based on different levels of aggregation.

All of our specifications include both the industry-specific export and import exchange rates. The export exchange rate series proxies the relevant stimuli to export market sales. The import exchange rate series combines the two other trade transmission channels for exchange rates, as shown in our theoretical derivation. Ideally, we would include separate measures for imported-input exchange rates and import-competition exchange rates. However, the import penetration of industries is highly correlated with the imported input shares of industries. Because of this strong correlation, the data do not allow us to effectively distinguish between the import-competition channel and the imported-input channel of exchange rate stimuli. Thus, we include only one import term. We recognize that the estimated parameter on the import exchange rate will combine the two distinct exposure effects. We cannot predict a priori the sign of its coefficient.

8.4.2 Regression Results: Nationally Aggregated Series for Industries

As a first pass through the data, we examine industry data on labor market outcomes collected at the national level. These regressions (shown in appendix table 8A.2) consider whether exchange rate movements are associated with changes in the employment, hours, or wages of workers who are differentiated from each other only in terms of the industries in which they work. In these national data, if a worker changes jobs within a two-digit industry, but moves across state lines, there will not be an observable change in employment. Because of this feature, such data may mask the extent of the possible disruption attributable to exchange rates. Employment changes show up in this data only when a worker moves in or out of a two-digit industry.

The regressions using industry aggregates on wages, hours, and employment impose various parameter constraints. The elasticity of labor market outcomes to exchange rate movements are constrained to be common across all industries, or to differ across industries or over time only due to differences in the industry trade orientation. We do not investigate with the national data differences in elasticities due to other industry-specific features, such as competitive structure (as in Campa and Goldberg 1998), labor market norms, or costs of adjusting the workforce. Given these cross-industry restrictions, it is not surprising that exchange rate implications appear small and generally insignificant for each of our labor market variables.

8.4.3 Regression Results: Data Disaggregated by States and by Industries

The main body of our empirical work, presented in tables 8.1 to 8.7, uses our full data set on labor market outcomes by industry, by state, and over time for the period 1971–95 (about 8,000 observations). Tables 8.1 to 8.3

Table 8.1 **Response Elasticities of Average Hourly Earnings of Workers in Industries in Individual States**

	High-Markup Industries			Low-Markup Industries		
	(1)	(2)	(3)	(4)	(5)	(6)
Own industry channels (percent change)						
Export exchange rates	0.053***			−0.009		
	(0.013)			(0.007)		
Import exchange rates	−0.050***			0.004		
	(0.009)			(0.009)		
State/industry export orientation with export exchange rates		0.011	0.011		−0.009***	−0.010***
		(0.008)	(0.009)		(0.003)	(0.003)
State/industry imported-input orientation with import exchange rates		−0.025***	−0.025***		0.007	0.004
		(0.008)	(0.009)		(0.006)	(0.006)
Cross-industry spillovers (percent change)						
Other-industry export orientation with export exchange rates			−0.005			0.002***
			(0.010)			(0.001)
Other-industry imported-input orientation with import exchange rates			.190***			0.011***
			(.041)			(0.004)

State-specific relative demand shock	0.249***	0.248***	0.271***	0.164***	0.173***	0.166***
	(0.056)	(0.056)	(0.057)	(0.049)	(0.049)	(0.049)
Forecasted state-specific relative demand shock	−0.118**	−0.116*	−0.124**	−0.584***	−0.063	−0.054
	(0.061)	(0.061)	(0.062)	(0.055)	(0.055)	(0.055)
Adjusted R^2	0.387	0.383	0.387	0.347	0.371	0.350
Test for joint significance of exchange rate terms: F-statistic						
Own-industry channels						
Noninteracted	14.64***			0.83		
Interacted with trade orientation		5.07*	4.25*		4.29*	5.35*
Cross-industry spillovers			10.74***			7.57***
Own-industry and cross-industry spillovers			7.92***			5.94*

Notes: BLS Employment and Earnings, states and area data. Weighted least squares estimation using prior period's employment levels as weights. Standard errors are given in parentheses. Number of observations is 7,991. Other control variables include industry-specific responses to real GDP changes, real oil-price changes, real interest rate changes, and state unemployment rate. Industry fixed effects, state fixed effects, and industry- and state-specific time trends are included in all specifications. Own-industry and other-industry export orientation measures are adjusted using MISER data to reflect average state/industry differences.

*Significant at the 10 percent level.

**Significant at the 5 percent level.

***Significant at the 1 percent level.

Table 8.2 **Response Elasticities of Average Hours of Workers in Industries within Individual States**

	High-Markup Industries			Low-Markup Industries		
	(1)	(2)	(3)	(4)	(5)	(6)
Own industry channels (percent change)						
Export exchange rates	−0.031***			−0.029***		
	(0.008)			(0.005)		
Import exchange rates	0.034***			0.019***		
	(0.006)			(0.007)		
State/industry export orientation with export exchange rates		−0.020***	−0.016***		−0.009***	−0.009***
		(0.005)	(0.006)		(0.002)	(0.002)
State/industry imported-input orientation with import exchange rates		0.031	0.001		0.007	0.000***
		(0.005)	(0.000)		(0.005)	(0.000)
Cross-industry spillovers (percent change)						
Other-industry export orientation with export exchange rates			−0.009			−0.001
			(0.007)			(0.001)
Other-industry imported-input orientation with import exchange rates			0.016			−0.001
			(0.026)			(0.003)

State-specific relative demand shock	−0.015	−0.004	0.005	0.091***	0.096***	0.097***
	(0.036)	(0.036)	(0.037)	(0.038)	(0.038)	(0.038)
Forecasted state-specific relative demand shock	−0.030	−0.036	−0.043	−0.161***	−0.163***	−0.164***
	(0.039)	(0.039)	(0.040)	(0.042)	(0.042)	(0.043)
Adjusted R^2	0.210	0.211	0.211	0.261	0.258	0.258
Test for joint significance of exchange rate terms: *F*-statistic						
Own-industry channels						
Noninteracted	16.82***			15.53***		
Interacted with trade orientation		17.11***	17.88***		7.08*	6.78*
Cross-industry spillovers			1.10			0.38
Own-industry and cross-industry spillovers			9.11***			3.73

Notes: BLS Employment and Earnings, states and area data. Weighted least squares estimation using prior period's employment levels as weights. Standard errors are given in parentheses. Number of observations is 7,991. Other control variables include industry-specific responses to real GDP changes, real oil-price changes, real interest rate changes, and state unemployment rate. Industry fixed effects, state fixed effects, and industry- and state-specific time trends are included in all specifications. Own-industry and other-industry export orientation measures are adjusted using MISER data to reflect average state/industry differences.

*Significant at the 10 percent level.

**Significant at the 5 percent level.

***Significant at the 1 percent level.

Table 8.3 **Response Elasticities of Average Employment of Workers in Industries within Individual States**

	High-Markup Industries			Low-Markup Industries		
	(1)	(2)	(3)	(4)	(5)	(6)
Own industry channels (percent change)						
Export exchange rates	0.064***			−0.030***		
	(0.018)			(0.009)		
Import exchange rates	0.033***			0.041***		
	(0.013)			(0.011)		
State/industry export orientation with export exchange rates		−0.035***	−0.051***		−0.003***	−0.003
		(0.011)	(0.012)		(0.004)	(0.004)
State/industry imported-input orientation with import exchange rates		0.118***	0.106***		0.072***	0.072***
		(0.011)	(0.012)		(0.008)	(0.008)
Cross-industry spillovers (percent change)						
Other-industry export orientation with export exchange rates			0.038***			−0.001
			(0.014)			(0.001)
Other-industry imported-input orientation with import exchange rates			0.189***			−0.003
			(0.056)			(0.005)

State-specific relative demand shock	0.110	0.156**	0.142*	0.237***	0.244***	0.245***
	(0.078)	(0.077)	(0.078)	(0.064)	(0.064)	(0.064)
Forecasted state-specific relative demand shock	−0.625***	−0.661***	−0.643***	−0.719***	−0.729***	−0.729***
	(0.085)	(0.084)	(0.084)	(0.072)	(0.072)	(0.072)
Adjusted R^2	0.568	0.575	0.578	0.565	0.567	0.567
Test for joint significance of exchange rate terms: *F*-statistic						
Own-industry channels						
Noninteracted	39.17***			27.62***		
Interacted with trade orientation		69.66***	40.59***		39.76***	39.62***
Cross-industry spillovers			10.71**			0.51
Own-industry and cross-industry spillovers			40.39***			20.13***

Notes: BLS Employment and Earnings, states and area data. Weighted least squares estimation using prior period's employment levels as weights. Standard errors are given in parentheses. Number of observations is 7,991. Other control variables include industry-specific responses to real GDP changes, real oil-price changes, real interest rate changes, and state unemployment rate. Industry fixed effects, state fixed effects, and industry- and state-specific time trends are included in all specifications. Own-industry and other-industry export orientation measures are adjusted using MISER data to reflect average state/industry differences.

*Significant at the 10 percent level.

**Significant at the 5 percent level.

***Significant at the 1 percent level.

separately consider the elasticities of response of real average hourly earnings, weekly hours, and employment, respectively. The industries are grouped together according to their average price-over-cost markups.[17] High-markup industries, all else equal, would be expected to have less responsive labor market outcomes.

For each industry group, tables 8.1 to 8.3 present the results of three specifications of exchange rate effects on the associated labor market outcome. The most constrained specifications are those given in columns (1) and (4) of each table, where the exchange rate effects are constrained to be common across industries in the group and over time. In columns (2) and (5), the exchange rate elasticities are allowed to vary with the size of the export orientation or the import orientation of an industry in a state and at any point in time. The coefficients on the exchange rate terms in these regressions are interpreted as the direct (and contemporaneous) implications for labor markets.[18]

Other useful summaries of the effects of exchange rates on the three dependent variables are given in tables 8.4 to 8.7. Table 8.4 provides independently estimated exchange rate elasticities for each industry. For the results reported in table 8.4, we constrain the industry-specific elasticities to be constant over time and across localities in the United States. In separate tests, we consider whether the data reject equality of the industry exchange rate elasticities across regions of the United States. If the answer is yes (reject equality), we report an r superscript on the associated term in table 8.4. For those industries where the data reject equality across regions, tables 8.5 to 8.7 provide details on the regional variation in the exchange rate effects.

Exchange Rates and Average Hourly Earnings

In state-level data, real exchange rates matter for average hourly earnings (table 8.1), even in the most constrained regression specifications. For both high- and low-markup industries, dollar appreciations generally lower the hourly earnings of workers.[19] For both categories of industries, the estimated magnitudes of the direct effects are small, with an average net effect of at most −0.1 percent from a 10 percent dollar appreciation. Indirect effects, from local industry spillovers, are significant, but on net go in

17. The low-markup group of industries includes primary metal products, fabricated metal products, transportation equipment, food and kindred products, textile mill products, apparel and mill products, lumber and wood products, furniture and fixtures, paper and allied products, petroleum and coal products, and leather and leather products.

18. We averaged the ratio of the MISER industry export orientation (by state) to the aggregate industry export orientation for the years covered by the MISER data. We then adjusted the aggregate industry export-orientation rates in each state and year by this average ratio.

19. The key exception is the positive earnings effect found for dollar appreciations through the export channel in high-markup industries.

Table 8.4 **Estimated Industry-Specific Elasticities of Labor Market Outcomes to Exchange Rates**

	Real Average Hourly Earnings (percent change)		Weekly Hours (percent change)		Employment (percent change)	
Industry	Export	Import	Export	Import	Export	Import
Food and kindred products	−0.203**	0.233**[r]	0.005	−0.003[r]	−0.045	0.087**
	(0.023)	(0.031)	(0.017)	(0.023)	(0.031)	(0.041)
Tobacco products	−0.084	−0.034	−0.036	−0.007	0.103	0.098
	(0.067)	(0.055)	(0.049)	(0.040)	(0.085)	(0.069)
Textile mill products	0.036	−0.073**	−0.114**	0.004	0.005	−0.007
	(0.031)	(0.033)	(0.023)	(0.024)	(0.043)	(0.046)
Apparel and other textile products	0.002	−0.015	−0.044**[r]	0.065**	0.082**[r]	−0.036[r]
	(0.014)	(0.029)	(0.010)	(0.022)	(0.019)	(0.040)
Lumber and wood products	−0.068**	0.129**	−0.006	−0.029	0.074**[r]	−0.043[r]
	(0.018)	(0.034)	(0.013)	(0.025)	(0.023)	(0.046)
Furniture and fixtures	0.086	−0.077	0.007	−0.014	0.091	0.000
	(0.053)	(0.073)	(0.039)	(0.054)	(0.072)	(0.099)
Paper and allied products	0.001	0.073**	−0.004	0.020	0.072**	0.009[r]
	(0.023)	(0.021)	(0.017)	(0.016)	(0.031)	(0.027)
Printing and publishing	0.032	−0.022	0.008	0.005	0.095**	−0.031
	(0.030)	(0.020)	(0.022)	(0.015)	(0.039)	(0.026)
Chemical and allied products	0.144**	−0.101**	0.000[r]	0.006[r]	−0.006	0.019
	(0.027)	(0.020)	(0.020)	(0.015)	(0.037)	(0.028)
Petroleum and coal products	0.078	−0.146**	0.106**	−0.061	0.021	−0.011
	(0.057)	(0.062)	(0.042)	(0.045)	(0.059)	(0.060)
Rubber and miscellaneous plastic	0.042	−0.069*	−0.058**	0.076**	0.065	0.188*
products	(0.033)	(0.040)	(0.024)	(0.030)	(0.042)	(0.051)

(*continued*)

Table 8.4 (continued)

	Real Average Hourly Earnings (percent change)		Weekly Hours (percent change)		Employment (percent change)	
Industry	Export	Import	Export	Import	Export	Import
Leather and leather products	0.036	0.015	−0.061	0.067**r	−0.126r	0.097
	(0.070)	(0.045)	(0.052)	(0.033)	(0.096)	(0.062)
Stone, clay, and glass products	0.139**	−0.118**	−0.037	0.044*	0.153**	0.011
	(0.052)	(0.036)	(0.038)	(0.026)	(0.067)	(0.047)
Primary metal industries	0.095**	−0.139**	−0.065**r	0.060**r	−0.054	0.124**
	(0.032)	(0.032)	(0.023)	(0.024)	(0.041)	(0.041)
Fabricated metal products	0.152**	−0.113**	−0.088**	0.031**	0.010	0.149**
	(0.024)	(0.019)	(0.018)	(0.014)	(0.032)	(0.025)
Industrial machinery and equipment	0.090**	−0.047**	−0.069**	0.052**	−0.097**r	0.129**
	(0.025)	(0.015)	(0.018)	(0.011)	(0.032)	(0.019)
Electronic and other electric equipment	0.043r	−0.049r	−0.088**	0.085**	0.473**	−0.161**
	(0.037)	(0.030)	(0.027)	(0.022)	(0.048)	(0.038)
Transportation equipment	0.235**	−0.126**	0.002r	−0.005	0.235**r	0.048**
	(0.027)	(0.016)	(0.020)	(0.011)	(0.032)	(0.018)
Instruments and related products	−0.124*r	0.066r	−0.077	0.073*	0.116	−0.080
	(0.070)	(0.055)	(0.051)	(0.041)	(0.094)	(0.074)
Miscellaneous manufacturing	−0.273**r	0.334**r	−0.050	0.060	0.157	−0.114
	(0.108)	(0.129)	(0.079)	(0.095)	(0.128)	(0.152)

Notes: Based on specification (1) from tables 8.1 to 8.3, where industry fixed effects were interacted with the percentage change in the industry-specific export and import exchange rates. Standard errors are given in parentheses.

*Significant at the 10 percent level.

**Significant at the 5 percent level.

rStatistically significant regional differences.

Table 8.5 **Regional Differences in Exchange Rate Implications for Average Real Hourly Earnings**

Industry Name	Reject Equality across Regions?	Combined Regional Coefficient (reported by region only if measurable)								
		Northeast	Mid-Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific
Food (SIC 20)										
XRER	no	−0.24***	−0.28***	−0.27**	−0.21***	−0.18***	−0.26***	−0.23***	−0.22**	−0.26***
		(0.09)	(0.05)	(0.04)	(0.05)	(0.04)	(0.06)	(0.05)	(0.10)	(0.05)
MRER	yes	0.32***	0.43***	0.41***	0.21***	0.21***	0.26***	0.22***	0.31***	0.37***
		(0.11)	(0.06)	(0.06)	(0.07)	(0.06)	(0.08)	(0.07)	(0.07)	(0.06)
Electronics (SIC 36)										
XRER	yes		−0.04	−0.01	−0.11	−0.13	−0.19	−0.35*		−0.42**
			(0.16)	(0.16)	(0.23)	(0.17)	(0.26)	(0.21)		(0.17)
MRER	yes		(0.02)	0.00	0.04	0.12	0.06	0.31*		0.31**
			(0.12)	(0.12)	(0.17)	(0.12)	(0.20)	(0.16)		(0.13)
Instruments (SIC 38)										
XRER	yes	0.09	−0.16	0.11	0.09	−0.31	0.40	−0.65	0.09	−0.67***
		(0.19)	(0.11)	(0.18)	(0.63)	(0.34)	(0.60)	(0.40)	(0.19)	(0.20)
MRER	yes	−0.15	0.12	−0.13	−0.04	0.23	−0.38	0.49	−0.15	0.52***
		(0.13)	(0.09)	(0.14)	(0.49)	(0.27)	(0.46)	(0.31)	(0.36)	(0.16)
Miscellaneous manufacturing (SIC 39)										
XRER	yes	−0.81*	−0.18	−1.00***	−0.02	−0.01	−0.81	−1.14***	−0.81*	0.19
		(0.40)	(0.12)	(0.23)	(0.44)	(0.37)	(0.40)	(0.35)	(0.40)	(0.19)
MRER	yes		−0.53	0.14	−0.39	−0.74		0.81	0.00	−0.83
			(0.49)	(0.55)	(0.67)	(0.62)		(0.63)	(0.63)	(0.52)

Notes: XRER, industry-specific export real exchange rates; MRER, industry-specific import real exchange rates. Standard errors are given in parentheses.

*Significant at the 10 percent level.

**Significant at the 5 percent level.

***Significant at the 1 percent level.

Table 8.6 **Regional Differences in Exchange Rate Implications for Average Weekly Hours**

Industry Name	Reject Equality across Regions?	Combined Regional Coefficient (reported by region only if measurable)								
		Northeast	Mid-Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific
Food (SIC 20)										
XRER	no	0.04	−0.01	0.07**	0.04	−0.01	0.03	−0.07*	0.01	0.01
		(0.06)	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)	(0.04)	(0.07)	(0.03)
MRER	yes		−0.05	−0.11	−0.09	−0.03	−0.01	0.07	−0.09	−0.05
			(0.08)	(0.08)	(0.08)	(0.08)	(0.09)	(0.09)	(0.09)	(0.08)
Apparel and fabric (SIC 23)										
XRER	yes	0.05	−0.00	0.01	0.02	−0.07***	−0.08***	−0.14***	0.05	−0.10**
		(0.05)	(0.02)	(0.06)	(0.16)	(0.02)	(0.03)	0.04	(0.05)	(0.04)
MRER	no	0.08	0.03	−0.03	−0.20	0.08*	0.10*	0.19**	0.08	0.03
		(0.10)	(0.04)	(0.11)	(0.30)	(0.05)	(0.06)	(0.09)	(0.16)	(0.07)
Chemicals and products (SIC 28)										
XRER	yes	0.01	0.04	0.00	−0.21*	−0.08**	−0.09	0.01*	0.01	0.02
		(0.07)	(0.03)	(0.04)	(0.10)	(0.04)	(0.06)	(0.06)	(0.07)	(0.07)
MRER	yes	−0.02	−0.01	0.00	0.17**	0.07**	0.05	−0.06	−0.02	0.01
		(0.05)	(0.02)	(0.03)	(0.08)	(0.03)	(0.05)	(0.04)	(0.08)	(0.05)

Leather and products (SIC 31)										
XRER	no	0.03	0.01	−0.31**	−0.14	−0.10	−0.23*	−0.32**	0.03	−0.09
		(0.07)	(0.07)	(0.15)	(0.13)	(0.23)	(0.13)	(0.14)	(0.07)	(0.18)
MRER	yes	0.02	0.02	0.35***	0.14	0.06	0.19*	0.36***	0.02	0.10
		(0.05)	(0.04)	(0.12)	(0.10)	(0.16)	(0.10)	(0.11)	(0.13)	(0.14)
Primary metal products (SIC 33)										
XRER	yes		0.09	0.04	−0.20	−0.10	−0.17	−0.09	−0.10	−0.06
			(0.10)	(0.10)	(0.15)	(0.11)	(0.12)	(0.13)	(0.18)	(0.12)
MRER	yes	0.08	0.04	−0.01	0.19*	0.18*	0.11	0.19**	0.16*	0.17**
		(0.08)	(0.04)	(0.03)	(0.11)	(0.06)	(0.07)	(0.08)	(0.08)	(0.08)
Transportation equipment (SIC 37)										
XRER	yes	−0.15	−0.10	0.12**	0.00	−0.10	−0.05	−0.21*	−0.06	−0.15**
		(0.10)	(0.09)	(0.05)	(0.12)	(0.11)	(0.15)	(0.12)	(0.37)	(0.07)
MRER	no		−0.05	−0.15**	−0.10	−0.02	−0.10	0.06	−0.02	−0.06
			(0.07)	(0.06)	(0.09)	(0.08)	(0.11)	(0.09)	(0.09)	(0.07)

Notes: XRER, industry-specific export real exchange rates; MRER, industry-specific import real exchange rates. Standard errors are given in parentheses.
*Significant at the 10 percent level.
**Significant at the 5 percent level.
***Significant at the 1 percent level.

Table 8.7 **Regional Differences in Exchange Rate Implications for Average Employment**

Industry Name	Reject Equality across Regions?	Combined Regional Coefficient (reported by region only if measurable)								
		Northeast	Mid-Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific
Apparel and fabric (SIC23)										
XRER	yes	0.07	0.04	0.11	−0.07	0.06*	−0.01	0.03	0.22	0.20***
		(0.07)	(0.03)	(0.07)	(0.19)	(0.03)	(0.04)	(0.06)	(0.28)	(0.05)
MRER	yes		−0.18	−0.45**	−0.12	−0.16	−0.21	−0.36**	−0.35**	−0.61***
			(0.14)	(0.18)	(0.39)	(0.15)	(0.16)	(0.17)	(0.17)	(0.17)
Lumber and wood (SIC 24)										
XRER	yes	0.09	0.06	−0.01	0.10	0.12***	0.09**	0.10**	−0.01	−0.03
		(0.08)	(0.06)	(0.04)	(0.12)	(0.04)	(0.04)	(0.05)	(0.08)	(0.03)
MRER	yes	0.31*	−0.32**	−0.02	−0.28	0.13*	−0.14	0.15	−0.07	−0.41***
		(0.18)	(0.13)	(0.08)	(0.31)	(0.08)	(0.10)	(0.10)	(0.10)	(0.07)
Paper products (SIC 26)										
XRER	no	0.02	0.07**	0.01	0.05	0.06	0.09*	0.01	0.03	0.14***
		(0.05)	(0.04)	(0.03)	(0.05)	(0.04)	(0.05)	(0.06)	(0.31)	(0.05)
MRER	yes	−0.03	0.06**	0.00	0.06	0.02	−0.06	0.01	−0.06	−0.16**
		(0.04)	(0.03)	(0.03)	(0.08)	(0.05)	(0.07)	(0.08)	(0.08)	(0.07)

Leather and products (SIC 31)										
XRER	yes	0.09	−0.05	−0.49*	−0.39	0.31	−0.76***	−0.10	0.09	−0.17
		(0.15)	(0.15)	(0.28)	(0.27)	(0.44)	(0.26)	(0.30)	(0.15)	(0.37)
MRER	no	0.02	0.05	0.41*	0.26	0.12	0.39*	0.24	0.02	0.10
		(0.10)	(0.09)	(0.22)	(0.21)	(0.30)	(0.20)	(0.23)	(0.27)	(0.29)
Industrial machinery (SIC 35)										
XRER	yes	−0.17	0.05	−0.09	−0.26***	0.07	0.10	−0.36***	0.03	0.20*
		(0.13)	(0.09)	(0.07)	(0.13)	(0.12)	(0.18)	(0.13)	(0.35)	(0.11)
MRER	no	0.12	0.05	0.16***	0.26***	0.13	0.08	0.27***	−0.02	0.09
		(0.08)	(0.05)	(0.04)	(0.08)	(0.08)	(0.12)	(0.08)	(0.08)	(0.08)
Transportation equipment (SIC 37)										
XRER	yes	−0.16	0.03	0.55***	0.22	0.15	0.40*	−0.64***	−0.07	−0.04
		(0.19)	(0.16)	(0.08)	(0.20)	(0.18)	(0.24)	(0.21)	(0.48)	(0.12)
MRER	no		−0.17	−0.28**	−0.23	−0.24	−0.26	0.09	−0.20	−0.14
			(0.13)	(−0.28)	(0.16)	(0.15)	(0.18)	(0.17)	(0.17)	(0.13)

Note: XRER, industry-specific export real exchange rates; MRER, industry-specific import real exchange rates. Standard errors are given in parentheses.
*Significant at the 10 percent level.
**Significant at the 5 percent level.
***Significant at the 1 percent level.

the opposite direction to that expected from the alternative wage arguments.

The first two columns of table 8.4 report the industry-specific estimates of average hourly earnings elasticities with respect to export and import exchange rates. Exchange rates enter significantly in 14 of the 20 industries. The separate channels for exchange rate effects can be large and sometimes offsetting. Clear examples of these counteracting forces are found in the food, chemical, and transportation equipment industries. In 8 industries the net elasticities of hourly earnings responses to exchange rates are significantly different from 0, but the sign pattern is mixed.

Table 8.5 shows the pattern of regional differences in earnings sensitivity for food, electronics, instruments, and miscellaneous manufacturing. For electronics, the West South Central and Pacific regions are most significantly effected by changes in the real exchange rates of export and of imported-input partners.

Exchange Rates and Average Weekly Hours

Dollar movements have significant implications for average weekly hours in manufacturing (table 8.2). When the dollar appreciates against the currencies of U.S. export partners, hours worked decline for both high- and low-markup industries. Symmetrically, when the dollar appreciates against the currencies of countries from which U.S. industries purchase inputs, hours worked expand. These two effects largely offset each other, so that the net effect of dollar movements on hours is small. We find no important cross-industry spillover effects of exchange rates on hours.

Estimates of industry-specific coefficients for the two transmission channels tell a similar story (table 8.4, cols. [3] and [4]). In 11 of the 20 industries, average weekly hours respond significantly to dollar movements through either the export or the import channels. While both channels for the exchange rate effects often are significant, the net effect on hours is significantly different from 0 only in the case of textile mill products and fabricated metal products (where a 10 percent appreciation reduces average weekly hours by 1.1 percent and 0.6 percent, respectively). Regional differences in the responsiveness of hours to dollar movements are evident for 6 of the 20 manufacturing industries. As shown in table 8.6, no single region has industry hours that are uniformly more responsive to exchange rates.

Exchange Rates and Average Industry Employment

The data show that exchange rate movements are clearly correlated with changes in industry employment (table 8.3). For high- and low-markup industries, these regressions support the expected pattern of direct effects through export and imported-input channels. Dollar appreciations against export partners are associated with employment declines (both through direct and indirect industry effects), while appreciations against input providers are associated with employment expansion.[20]

There is considerable heterogeneity across industries in the effect of dollar movements on employment (table 8.4). In 13 of the 20 industries, employment is responsive to exchange rates through at least one of the trade channels. At the state level, some of these local employment effects are very large, even in net terms. Regional differences in employment elasticities are important for 6 of the 20 manufacturing industries (see table 8.7).

During the full time period (1971–95), the net effect of a dollar appreciation appears to be expansion of employment. However, tests of the stability and robustness of the regression coefficients across different subperiods suggest that caution is warranted. The coefficient estimates are fairly stable or sign-consistent into the mid-late 1980s, but for the late 1980s and early 1990s the fit of the regression equations significantly deteriorates. In many cases, there are even sign reversals on many estimated coefficients.

Actual versus Anticipated Shocks, and Local Labor Markets

Finally, the results from our constructed measures of state relative demand shocks are of independent interest for understanding the dynamics of labor market adjustment to stimuli. Using Current Population Survey data from 1977–79, Topel (1986) finds that an increase in his current relative demand-shock measure leads to significantly higher average weekly wages. In contrast, an increase in his expected future relative demand shock measure leads to significantly lower average weekly wages. Topel interprets the positive wage response to the current shock as consistent with a labor-demand shift with a stable labor supply, and the negative wage response to expected future shocks as consistent with a labor-supply shift with a stable labor demand. The current labor supply shifts in advance of expected future labor-demand shifts as workers attempt to arbitrage lifetime earnings differentials across separate labor markets.

While our study uses aggregate data and not microdata and controls for a different set of variables, our results nonetheless confirm Topel's pattern of wage adjustments to these state relative demand shock measures. Average weekly wages show a large positive and statistically significant response to current relative demand shocks. In addition, average weekly wages fall in response to expected future relative demand shocks (table 8.2). For both high- and low-markup industries, the elasticity with respect to the current shock is more than double the elasticity with respect to the expected future shock.

If the local market experiences a demand shock that is large relative to

20. Again, the exception is for dollar appreciations through the export channel for high-markup industries where we find a positive employment effect. However, when we interact the export exchange rate with the industry export intensity we find the predicted negative employment effect.

the shocks experienced by other localities, we also expect local employment and hours to increase.[21] From table 8.2, we observe a significant qualitative difference across high- versus low-markup industries on the response of hours worked. Hours worked in low-markup industries are very sensitive to relative local demand conditions: Hours increase in response to the current (favorable) shocks, and decrease in anticipation of future (favorable) shocks. Table 8.3 confirms the same sign pattern of employment adjustment to these shocks, and suggests that market structure may play a role in determining the magnitude of responsiveness to current shocks. Although wages were more responsive to current shocks, hours and employment are more responsive to perceived future conditions.

8.5 Conclusion

In this paper we have used labor market data disaggregated by industry and by state to explore the labor market implications of exchange rates. This approach offers several potential advantages over prior studies. First, we can better specify the alternative wage by using data at the state versus the national level. Second, given the nonrandom distribution of industry employment across labor markets, aggregate industry-level data may pick up spurious state- or region-specific labor market effects. Third, we are able to introduce state- and industry-specific export-orientation data and can consider spillovers within and across labor markets. Finally, and importantly, if exchange rate movements lead to reallocation of workers and jobs across state lines, but still within similar industries, we are likely to pick up some effects that may be missed in industry data aggregated from the state to the national level.

We find that local industries differ significantly in their earnings, hours, and employment responses to exchange rates. Industry wages unambiguously respond to dollar movements in 8 of the 20 manufacturing industries, with possible effects surfacing in 14 of the 20 industries. A dollar depreciation is sometimes associated with earnings growth, but sometimes with wage restraint. In some industries, there are significant regional differences in these elasticities. Employment is unambiguously responsive to exchange rates in 12 of the 20 manufacturing industries. The employment effects of exchange rates are much more easily discerned in the local labor markets than in nationally aggregated series. However, there are clear issues of the stability of empirical specifications that become especially pronounced by the late 1980s. This lack of stability leads us to suggest caution in interpreting and identifying industry-specific responses of labor market outcomes to dollar movements.

21. Topel (1986) only looks at the impact on average weekly earnings.

Appendix

Local Relative Demand Conditions and Forecast

For each state r and industry i, we construct a time series of private-sector nonagricultural employment excluding employment in that industry[22] and regress its logarithm on a quadratic time trend. The residuals from these regressions, ε_t^{ir} measure the deviations from trend employment in state r exclusive of industry i at time t. Similarly, we regress the logarithm of national private sector nonagricultural employment in year t on a quadratic time trend. The residuals from this regression, ε_t, capture the aggregate business cycle. Relative local demand shocks in state r and industry i in year t are defined as

$$\Delta y_t^{ir} = \varepsilon_t^{ir} - \varepsilon_t, \tag{A1}$$

so that the relative demand shock measures the local employment shock as a deviation from the national employment shock.

We use the persistence of these relative demand shocks to develop a measure of the expected future relative shock to a state/industry. Specifically, for each state/industry we estimate the following regression:

$$\Delta y_t^{ir} = \alpha_1^{ir} \Delta y_{t-1}^{ir} + \alpha_2^{ir} \Delta y_{t-2}^{ir} + \beta^{ir} \varepsilon_t. \tag{A2}$$

The relative demand shock for industry i in state r is modeled as a function of two lags of the relative demand shock and the current national shock. If β^{ir} is positive, then this industry/state experiences relative cycles that are magnified by the aggregate cycle. This empirical model is used to generate 1- to 3-year forecasts of the relative demand shocks for each industry/state. We use a second-order autoregressive model to forecast the national employment shocks. Following Topel (1986), we summarize these forecasts into a single weighted average of the forecasts, with weights declining linearly over the forecast horizon.

22. Here is where we deviate from Topel's methodology. Since we are interested in explaining the impacts of relative demand shocks on the wage, hours, and employment in an industry/state, we must remove any direct contribution of that industry/state from our measure of the relative demand shock. We do this by subtracting the employment movements in that industry from our time series on state employment. This implies that each manufacturing industry in a state will have a slightly different series of estimated relative demand shocks.

Table 8A.1 **Correlation Coefficients between Industry-Specific Real Exchange Rates and an Aggregate Real Exchange Rate**

Industry Name (code)	XRER with RER	MRER with RER	XRER with MRER
Food and kindred products (20)	0.89	0.93	0.92
Tobacco products (21)	0.88	0.76	0.56
Textile mill products (22)	0.88	0.85	0.75
Apparel and other textiles (23)	0.77	0.82	0.61
Lumber and wood products (24)	0.63	0.58	0.48
Furniture and fixtures (25)	0.79	0.82	0.71
Paper and allied products (26)	0.92	0.50	0.45
Printing and publishing (27)	0.91	0.81	0.76
Chemical and allied products (28)	0.93	0.89	0.92
Petroleum and coal products (29)	0.90	0.36	0.34
Rubber and miscellaneous plastic (30)	0.83	0.87	0.68
Leather and leather products (31)	0.91	0.65	0.55
Stone, clay, and glass (32)	0.85	0.86	0.76
Primary metal industries (33)	0.90	0.82	0.81
Fabricated metal products (34)	0.84	0.80	0.60
Industrial machinery and equipment (35)	0.92	0.85	0.85
Electronic and other equipment (36)	0.88	0.76	0.67
Transportation equipment (37)	0.90	0.75	0.73
Instruments and related products (38)	0.91	0.81	0.89
Miscellaneous manufacturing (39)	0.90	0.88	0.90

Notes: The industry-specific export real exchange rates are denoted by XRER; industry-specific import real exchange rates are denoted by MRER; the trade-weighted aggregate real exchange rate is the Federal Reserve Bank of Dallas series.

Table 8A.2 Nationally Aggregate Industry Data on Earnings, Hours, and Employment, 1971–95

	Real Average Hourly Earnings (percent change)		Average Weekly Hours (percent change)		Average Employment (percent change)	
	(1)	(2)	(3)	(4)	(5)	(6)
Export exchange rates	0.018		0.002		0.072**	
	(0.018)		(0.008)		(0.027)	
Import exchange rates	−0.014		−0.008		0.023	
	(0.014)		(0.007)		(0.022)	
Industry export orientation with export exchange rates		−0.008		−0.011		0.016
		(0.016)		(0.007)		(0.022)
Industry imported-input orientation with import exchange rates		0.003		−0.002		0.046**
		(0.014)		(0.006)		(0.021)
Real GDP	0.104**	0.108**	0.236**	0.237**	0.879**	0.921**
	(0.037)	(0.037)	(0.017)	(0.017)	(0.055)	(0.054)
Real oil prices	−0.035**	−0.035**	0.004**	0.004**	0.016**	0.017**
	(0.004)	(0.004)	(0.002)	(0.002)	(0.006)	(0.006)
Real interest rates	−0.009	−0.011	0.010*	0.009*	0.081**	0.090**
	(0.012)	(0.012)	(0.006)	(0.005)	(0.018)	(0.017)
National unemployment rate	0.003*	0.002*	0.001	0.001	−0.009**	−0.007**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Lag employment growth	−0.094**	−0.094**	−0.164**	−0.164**	0.106**	0.137**
	(0.029)	(0.029)	(0.013)	(0.013)	(0.043)	(0.041)
Adjusted R^2	0.629	0.628	0.586	0.589	0.570	0.567
Test for joint significant of exchange rate terms: *F*-statistics, [Change in adjusted R^2]						
Noninteracted	0.69		0.66		5.87**	
	[−0.0007]		[−0.0008]		[0.0122]	
Interacted with trade orientation		0.013		1.91		4.79**
		[−0.0019]		[0.0022]		[0.0093]

Notes: BLS Employment and Earnings, national data. Weighted least squares estimates with the weight being last period's employment level. Standard errors are given in parentheses. Specifications include a time trend and industry fixed effects. Number of observations is 368 for average hourly earnings and average weekly hours, and 400 for average employment.

*Significant at the 10 percent level.

**Significant at the 5 percent level.

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Comment Andrew K. Rose

To Begin

In this paper, Goldberg and Tracy perform exactly the sort of careful empirical work which I like to see done. I'm happy someone did it. More precisely, I'm happy someone *else* did it. There are two reasons. First, they did it very well. This paper was very thorough and very careful, and the results are completely believable. But those results can, I think, be reasonably described as being "less than completely successful." There's a reason why economists differentiate between doing "theory" and "empirical work," rather than "theory work" and "empirics." It sometimes takes remarkable effort (and this paper clearly represents a lot of work) before one can run the regressions that disclose remarkably little.

This paper had to be written; it addresses a question of enormous policy import. We certainly want to know what the impacts of exchange rate changes are on labor markets, and we want to know if they differ substantially by region and industry. So Goldberg and Tracy are clearly asking a good question. What is their answer? The message I personally take away is that the effects of exchange rates on wages, employment, and hours are surprisingly small at both aggregate and disaggregated levels. While they find statistically significant differences in these impacts across regions and industries, those effects don't appear to be that economically important. Their meticulous work does not uncover economically important effects that were hidden by aggregation. Since I think that this result is probably robust (I find it hard to believe that it could be overturned by an even more disaggregated look at the data), it's a strong but negative statement. Negative results are important in this case, since they make our lives easier in a nontrivial way; it is much easier to stay at the aggregate level, if one can. So I don't want to underplay the importance of their nonresults. But they are still nonresults. We still haven't found the illusive strong sensible effects of exchange rates on labor markets.

The Question

Goldberg and Tracy are interested in seeing whether the exchange rate affects regions and industries differently across the country, and whether these effects come in the form of wage adjustments, employment growth, or changes in hours. Why is this an important issue? Industries are subject to different effects from the exchange rate depending on how export oriented they are, who their competitors are, and whether their inputs come

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from abroad. And regions differ in their industrial composition. Suppose particular geographic constituencies are more dramatically affected by exchange rate pressures than others. Then political bodies that are geographically formed (e.g., the U.S. Senate) might be more willing to pass protectionist legislation than ones that are based on population (e.g., the House of Representatives). Similarly, if exchange rate changes have important industrial effects, one might expect lobbyists and pressure groups to be industrial rather than regional. For these reasons, and a hosts of others, disaggregating the effects of exchange rate changes is of great intellectual interest.

This is a formidable task, and a worthy one; the authors are clearly ambitious. At least two substantial tasks are entailed. First, the authors need to create a theoretical framework in which to construct their empirical work. Second, they have to create a data set that is disaggregated in three dimensions—time, location, and industry. Exploiting this data set is a lot easier than creating it, and unfortunately one has no clear idea of whether it will be worth all the trouble until the costs have been borne.

The theoretical part of the paper is reasonable and relatively straightforward. It forms a good framework for the paper and allows us to understand the results. It is a necessary part of the paper, but not, in my judgment, where most of the value added lies. The second part of the paper is empirical, and it is the chief contribution, so I will discuss it at greater length.

A caveat before I begin. This study is concerned with the impact of exchange rates on manufacturing trade. While historically most trade has been in goods, my home state of California is home to a large growing export-oriented service industry. The 1997 *Economic Report of the President* (table B-104) shows that in 1995, exports of services were worth $211 billion; exports of goods were valued at $576 billion. The authors are limited by the available data, but it is still important to remain aware of these limitations. And manufacturing is only around 15 percent of American employment in any case.

The Answer

The authors have some of the standard problems of using microdata. For instance, they frequently have results that are difficult to summarize (since they seem to be contradictory), for instance, exchange rate effects that differ by time period. On the other hand, they don't have one standard problem that plagues most applied economists working with large data sets. "Left-handed labor economists" earned that nickname because in a regression of 10,000 observations of anything on anything, everything is usually significant (including being left-handed). As a result, most people who do such things are informal Bayesians; they tighten significance levels with degrees of freedom. Yet in this paper, remarkably few effects are significant (manifest in the use of an asterisk to denote significance at the 10 percent level).

This is the heart of the matter. Consider table 8.1, which portrays the effects of exchange rates on wages. The estimation uses thousands of observations in an extensive panel disaggregated by time, industry, and state, split into different classes (by markups), with many controls, and both direct and indirect channels for exchange rate effects. This setup is not only theoretically sensible, but it seems to deliver the empirical goods in some dimensions; the effects of GDP are large in both economic and statistical terms. But the exchange rate effects are simply not, as the authors acknowledge. The elasticities are small, vary in sign, and cannot easily be summarized. While somewhat larger effects are found for employment, the effects essentially remain economically very small. They also seem to vary a lot over time and are often counterintuitive. Hours look even worse. Tables 8.1 through 8.3 don't present a strong prima facie case for disaggregating by region.

Table 8.4 is the crux, which reports the effects of exchange rate changes on labor market outcomes by industry. In only 8 of the 20 industries do exchange rates affect wages; 4 with positive elasticities, 4 negative, and none large. Hours and employment look similar. I interpret this evidence as saying that the effects that we all believe are buried somewhere in the data are illusive.

To Conclude

In the end, I ask myself: Have Goldberg and Tracy made the case for disaggregation? In my opinion, the answer is no. In some sense this is a negative result; a lot of careful work turned out not to deliver big results. But in an important sense, this negative result is very useful to us all. Dealing with disaggregated models and data is a pain. Finding out that aggregating across industries doesn't seem to do enormous violence is an extremely useful simplification, and we owe them a debt for discovering it.

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